

REMARKS

By this response, claims 1 and 20 have been amended and new claims 21-23 have been added. Support for new claims 21-23 can be found throughout the specification, in particular, at paragraph [0019]. No new matter has been added. Claims 7, 16, and 19 were previously canceled. Claims 1-6, 8-15, 17, 18, and 20-23 are pending.

In the office action of June 28, 2007 the Examiner: rejected claims 1, 8, 9, 11, 12, 15, and 18 under 35 USC §102(b) over U.S. Patent No. 5,643,407 ("Chang '407"); rejected claims 5, 6, and 17 under 35 USC §103(a) over Chang '407 in combination with U.S. Pub. 2003/0104320 ("Nguyen et al."); rejected claims 2-4, 10, 13, and 14 under 35 USC §103(a) over Chang '407 in combination with Nguyen '320 and further in view of U.S. Pub. 2003/0008518 ("Chang '518"), U.S. Patent No. 6,107,202 ("Chiu et al."), and U.S. Patent No. 6,417,108 ("Akino et al."), and; rejected claim 20 under 35 USC §103(a) over U.S. Pub. 2002/0058397 ("Smith et al.").

Reconsideration of the application as amended is respectfully requested.

Examiner Interview

Applicants thank the Examiner for granting and conducting an interview for the subject application on October 23, 2007 in which the Applicants and the Examiner generally discussed the Chang reference, US 5,643,407. While no agreement was reached on the matters discussed at that time, the Applicants appreciate the Examiner's time, and consideration of the claims as amended in light of the arguments presented below.

Rejections under 35 USC §102(b)

Claims 1, 8, 9, 11, 12, 15, and 18 have been rejected under 35 USC §102(b) as being anticipated by Chang '407.

It is submitted that the rejected claims as amended are novel over the disclosure of Chang '407.

Claim 1 recites a method of cleaning a wafer including, among other things, cleaning a polymer residue from surfaces of the patterned dielectric layer using a wet clean solvent, performing a non-plasma anneal on a porous, low-k, patterned dielectric layer to remove a component of the solvent and, after an anneal duration of about six minutes or less, stopping the anneal.

In contrast, Chang '407 discloses a method comprising baking a wafer in a vacuum for between 20 and 40 minutes to remove moisture generated during decomposition of the organic spin-on-glass material during O₂ ashing of the photoresist (col. 3, lines 30-36).

Claim 1 of the present application recites "performing a non-plasma anneal...to *remove a component of the solvent.*" Chang's process is performed to remove moisture, not to remove a component of the solvent as currently claimed. Thus, Applicants submit that claim 1 is allowable over Chang '407.

Claim 1 is further allowable, as Chang '407 fails to disclose stopping the anneal after an anneal duration of about six minutes as recited by claim 1 of the present application.

For the reasons discussed above, Applicants request that the Examiner reconsider and withdraw the rejection of claims under 35 USC §102(b). Applicants

submit that claim 1 is in condition for allowance, as are claims 8, 9, 11, 12, 15, and 18 at least by virtue of their dependency from allowable claim 1.

Rejections under 35 USC §103(a)

Claims 5, 6, and 17 have been rejected under 35 USC §103(a) over Chang '407 in combination with Nguyen et al.

Claims 5, 6, and 17 recite through claim 1 from which they depend, among other things, a method comprising cleaning a polymer residue from surfaces of the patterned dielectric layer using a wet clean solvent, performing a non-plasma anneal on the patterned dielectric layer to remove a component of the solvent, and after an anneal duration of about six minutes or less, stopping the anneal.

To establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must teach or suggest all the claim limitations. However, the combination of references do not appear to teach or suggest the recitations of the rejected claims.

Chang '407 discloses a method comprising etching a dielectric layer using a photoresist layer as a pattern; removing the photoresist using a wet strip followed by an optional oxygen plasma ashing to ensure all the photoresist residue is removed; vacuum baking the wafer at a pressure of 10 mTorr or less and a temperature of between about 250°C to about 350°C for a duration of between about 20 to 40 minutes in a nitrogen ambient, and; performing a nitrogen plasma treatment to convert the organic dielectric to an inorganic dielectric (col. 3, lines 13-48).

Nguyen et al. is cited for its description of conventional semiconductor processing methods, specifically that the conventional photoresist removal sequence

typically consists of a dry strip using oxygen to remove the bulk of the photoresist layer followed by a wet clean process to remove the residues and metal contaminants, and that the conventional sequence further includes an anneal step to remove any moisture resulting from the wet strip (¶7).

It is well established that excessive heat is detrimental to semiconductor structures during processing and that process engineers attempt to minimize the exposure of the semiconductor wafer to heat to remain within a "thermal budget." Chang '407 recites performing the baking step for 20 to 40 minutes (col. 3, line 24), and thus it appears that 20 minutes would be a minimum baking time to practice Chang's method. To conserve the thermal budget, Chang '407 would have minimized the anneal duration. Moreover, Chang '407 states that this baking step is part of a critical process of the invention (col. 3, lines 30-33).

Claims 5, 6, and 17 of the present application are allowable at least for the recitation that the anneal is stopped after a duration of about six minutes. Because 20 minutes is a critical requirement of Chang '407 as discussed above, and therefore a requirement for the combination of Chang '407 and Nguyen, all of the claim limitations are not taught or suggested by the combination of references as required (MPEP §706.02j).

Further, Chang '407 discloses a method performed to remove moisture generated during decomposition of the organic spin-on-glass material during O₂ ashing of the photoresist (col. 3, lines 30-36). Claim 1 of the present application through which claims 5, 6, and 17 depend recites "performing a non-plasma anneal...to remove a

component of the solvent." Chang '407's process is performed to remove moisture, not to remove a component of the solvent.

Because Chang '407 and Nguyen fail to teach or suggest every feature of the recited method, for example performing the process to remove a component of the solvent and an anneal duration of six minutes or less as discussed above, claims 5, 6, and 17 are allowable under 35 USC §103(a) for at least this reason.

Claims 2-4, 10, 13, and 14 have been rejected under 35 USC §103(a) over Chang '407 in combination with Nguyen as applied to claims 5, 6, and 17, and further in view of Chang '518, Chiu et al., and Akino et al.

Chang '407 and Nguyen recite the disclosure discussed *supra*. With regard to claim 2, Chang '518 recites MSQ as a low-k dielectric (claim 14). With regard to claim 4, Chiu '202 recites DMAC (col. 8, last line).

As discussed relative to the rejection of the claims over a combination of Chang '407 and Nguyen '320, the combination of references fail to teach or suggest that the anneal is stopped after a duration of about six minutes, and the disclosure of Chang '407 requires a minimum duration of 20 minutes. Further, Chang's process is performed to remove moisture generated from the decomposition of the organic spun-on-glass, not to remove a component of the solvent as recited in claim 1 from which the rejected claims depend. Because all of the claim limitations are not taught or suggested by the combination of references as required (MPEP §706.02j), rejected claims 2-4, 10, 13, and 14 are therefore allowable under 35 USC §103(a) for at least this reason.

Claim 20 has been rejected under 35 USC §103(a) as being unpatentable over Smith et al. (US Pub. 2002/0058397).

Claim 20 as amended recites performing an anneal at a pressure of about one atmosphere or less and a temperature of between about 250°C and about 300°C after a wet clean process and, after an anneal duration of about six minutes or less, stopping the anneal.

In claims 1-4, Smith '397 recites subjecting the semiconductor wafer to a plasma so as to remove the photoresist layer, removing the polymeric residue using a wet etch chemistry, subjecting the semiconductor wafer to an annealing step to remove any excess fluid from action of the wet etch chemistry on the semiconductor wafer. In ¶127, Smith '397 discloses that the anneal may be on the order of 60°C and appears to be silent with regard to pressure and duration.

The Examiner states that it would have been obvious for one skilled in the art to use the process taught by Smith '397 to remove volatile cleaner compounds from a post-etch substrate because the terms "high-temperature anneal" and "limited-duration anneal" as originally used in claim 20 were very broad. In accordance with the Examiner's suggestion, the amendments to claim 20 recite the claimed invention with more specificity. Because Smith '397 fails to teach or suggest every limitation as required (MPEP §706.02j), claim 20 is allowable over Smith '397 under 35 USC §103(a).

Any rejected claim not individually addressed is allowable for at least depending from an allowable base claim.

New Claims

The newly-added claims (supported in the original specification, for example at ¶19) are allowable over the cited references, which fail to teach or suggest the recited method as claimed including, among other things, "performing a non-plasma anneal on the patterned dielectric layer at a temperature of about 250°C for a duration of about 45 seconds" (claim 21), and further performing the method at the recited temperature and duration "at a pressure of about one atmosphere or less" (claim 22), and further "performing the non-plasma anneal to remove a component of the wet clean solvent." A duration of "about 45 seconds" is less than 1/26 the duration of Chang's minimum duration, is novel and nonobvious over Chang's disclosure, and is therefore allowable over the cited references. Further, Chang's process is performed to remove moisture in contrast to claim 23 in which the non-plasma anneal is performed to remove a component of the wet clean solvent.

Conclusion

In view of the foregoing amendments and remarks, Applicant respectfully requests reconsideration and reexamination of this application and the timely allowance of the pending claims. This is believed to be a complete response to the Examiner's office action.

Please grant any extensions of time required to enter this response and charge any additional required fees to Texas Instruments' deposit account 20-0668.

Respectfully submitted,

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